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G87-862 Holding Wet Corn With Aeration (Revised July 1995)

David D. Jones
University of Nebraska - Lincoln, david.jones@unl.edu

Robert D. Grisso
University of Nebraska - Lincoln

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Holding Wet Corn With Aeration

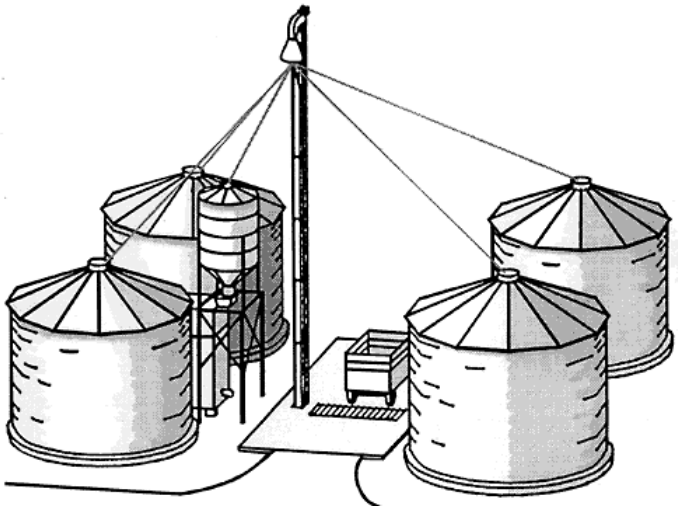
This NebGuide discusses aeration recommendations and corn moisture level limitations for holding wet corn under Nebraska conditions.

David D. Jones, Associate Professor, Biological Systems Engineering
Robert D. Grisso, Extension Engineer, Biological Systems Engineering

Corn is a perishable commodity with a limited shelf life that depends on the moisture content and temperature of the corn. `Shelf life' is the length of time good quality, aerated shelled corn can be stored before losing one-half percent of dry matter. With this amount of dry matter decomposition, it is assumed that the corn loses some quality, but maintains its market grade.

These storage times do not always predict well the point at which mold growth becomes visible on individual corn kernels. To illustrate this point, consider aerated corn at 18 percent moisture content and 70°F. This corn has a shelf life of approximately 31 days.

At that same temperature, aerated corn at 24 percent moisture content only has a shelf life of approximately 6 days. Clearly, the limited shelf life of high moisture content corn precludes extended storage of this corn.



Here we discuss temporary storage, or holding, of wet corn with aeration. The recommendations in this NebGuide should allow for storage until the corn can be dried (and then held for longer periods), or removed from the bin for feeding or other purposes. We define wet corn as corn with 16 percent or higher moisture content.

When holding wet corn, aeration is required. The temperature of the corn mass will not remain constant because biological activity of the corn releases heat that increases corn temperature. The higher corn temperature, in turn, increases biological activity, which can rapidly lead to corn deterioration. Aeration systems are needed to offset this temperature rise and to adjust the corn temperature to ambient temperatures. Without aeration, wet corn cannot be held.

Successfully holding wet corn requires an understanding of aeration systems and the effects of corn moisture, temperature, and damage levels on shelf life of the corn.

Estimated Shelf Life

Table I can be used to estimate the shelf life of aerated corn based on the moisture content and temperature of the corn. The shelf life data are not valid for corn held without aeration. Unaerated corn may deteriorate three times faster than indicated by the shelf life data in *Table I.*

Table I. Shelf life (days) for aerated, shelled corn. These values also may be used to estimate allowable storage times for other grains.

Corn Temperature, °F	Corn Moisture Contents (Wet Basis)							
	16%	18%	20%	22%	24%	26%	28%	30%
30	939*	648*	321*	190*	127*	94*	74	61
35	626*	432*	214*	126*	85	62	49	40
40	418*	288*	142*	84	56	41	32	**27**
45	279*	192*	95	56	37	**27**	**21**	**18**
50	186*	128	63	37	**25**	**18**	**14**	**12**
55	123*	85	42	**25**	**16**	**12**	**9**	**8**
60	81	56	**28**	**17**	**11**	**8**	**7**	**5**
65	61	42	**21**	**13**	**8**	**6**	**5**	**4**
70	45	**31**	**16**	**9**	**6**	**5**	**4**	**3**
75	33	**23**	**12**	**7**	**5**	**4**	**3**	**2**

Bold numbers: Corn held at these temperatures and moisture contents require frequent inspection and continuous aeration.
* Under Nebraska weather conditions, corn temperatures cannot be maintained at these levels for the indicated length of time.

The shelf lives given in this table represent the lengths of time that good quality, aerated shelled corn can be stored before losing one-half percent of dry matter at various temperatures and moisture contents. With this amount of dry matter decomposition, it is assumed that the corn loses some quality, but maintains its market grade.

These storage times do not always predict well the point at which mold growth becomes visible on individual corn kernels. Visible mold growth may occur sooner than expected when the corn is held at conditions where the shelf life is less than one month. If corn is to be fed to gestating or lactating sows, a more vigorous inspection routine is recommended. (For more details, see NebGuide *G94-1199, Management to Maintain Stored Grain Quality*.)

An area of possible confusion is that the shelf life data were determined for aerated corn maintained at a constant temperature over the entire storage period. In practice, corn is not aerated while held in the truck, and the temperature changes from harvest temperature to storage temperature.

Corn deterioration is a cumulative process and remaining shelf life progressively decreases during each storage interval. The amount of decrease depends on the corn moisture and temperature for a storage interval. To use *Table I*, you need to accumulate the percentages to determine the safe storage period.

For example, assume corn was harvested at 24 percent moisture content and allowed to remain in a truck overnight (0.5 days) before unloading. The average temperature in the truck was 70°F and the corn was then placed in a holding bin equipped with a cooling fan. If the corn was cooled to 40°F in two days, how long can the corn be held at 40°F without exceeding the shelf life?

Step 1: Consider the newly harvested corn in the truck. Enter the description of the operation in column 1 of the worksheet. The corn in the truck was held for 12 hours (0.5 days) so enter 1/2 in column 2 of the worksheet. Add the value in column 2 to the value in the preceding row in column 3 to determine the total number of days. Enter the grain temperature (70°F) in column 4 and the moisture content (24 percent) in column 5. The shelf life for corn at 24 percent moisture content and 70°F is six days. The shelf life data presented in Table I are for corn that is aerated, but there is no aeration in the truck. Corn deteriorates three times faster when no aeration is used, so the shelf life for the corn in the truck is 6 days/3 = 2 days. Enter this value in column 6 of the worksheet. To determine the storage life used, divide column 2 by column 6 of the worksheet.

0.5 days/2 days = 0.25 or 25 percent of the shelf life used while the corn was in the truck.

Enter this value in column 7 of the worksheet. The storage life remaining (column 8) is calculated by subtracting the value in column 7 from the preceding row in column 8. In this case the result is 75 percent.

Step 2: Consider the corn during the cooling process. The temperature of the corn is reduced from 70°F to 40°F (55°F average temperature) in two days. The shelf life of corn at 55°F and 24 percent moisture content (from *Table I*) is 16 days.

2 days/16 days = 0.125 or 12.5 percent of the shelf life used during the two days of cooling.

The process is illustrated in the worksheet.

Step 3: In the final step, the length of time in storage is unknown (column 2 of the worksheet). As in the previous steps, enter the description of the operation in column 1. Enter the grain temperature and moisture content in columns 4 and 5, respectively. Determine from *Table I* the shelf life for corn at 40°F and 24 percent moisture content (56 days) and enter the value in column 6. In this case you are interested in consuming all of the remaining storage life in this operation. Therefore, enter the value (62.5 percent) from column 8 of the preceding row in column 7. Furthermore, column 8 will reflect 0 percent of the storage life remaining. The length of time in storage (column 2) can now be calculated by multiplying the value in column 6 and column 7. In this case, 62.5 percent of the 56 days, or 35 days of shelf life, remain. Column 3 now can be updated.

Example worksheet to calculate remaining storage life.							
(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
Operation	**Length of Time in Operation (Days)**	**Total Time (Days)**	**Grain Temperature (°F)**	**Moisture Content (% wb)**	**Shelf Life From Table I (Days)**	**Storage Life Used (%)**	**Storage Life Remaining (%)**
__	__	0	__	__	__	__	100
Truck	1/2	1/2	70	24	2*	25	75
Cooling	2	2 1/2	55	24	16	12.5	62.5
Storage	35	37 1/2	40	24	56	62.5	0
* Since no aeration is used while the corn is in the truck, divide the value from *Table I* by 3.							

Deterioration rates also vary depending on corn condition. For example, the amount of damage that occurred during harvesting and handling operations, and previous mold or insect infestation, influence deterioration rates. Damaged corn molds faster than corn with a sound seedcoat. It is not unusual to see mold develop on fines and broken kernels several weeks before it becomes apparent on undamaged corn kernels.

The allowable storage times given in *Table I* assume typical harvest damage levels (1.5 - 2 percent), and may be conservative for wet corn that is screened before being put into storage. On the other hand, the storage times may be optimistic if excessive damage exists. While allowable shelf life data provides valuable information for holding corn, the values should be viewed as guidelines and should not be considered absolute. An empty worksheet on the back page is included for your specific operation and computations.

Aeration Systems

A well-designed aeration system is necessary to safely hold wet corn for even short periods of time. Adequate air-flow within the corn mass is essential to carry away heat generated by mold and corn respiration. This is particularly important when holding corn with shelf lives of less than one month.

Research has shown that corn in this condition needs to be cooled within one or two days after being placed in the bin to avoid significant mold damage. This rapid cooling rate can be achieved only in bins with fully perforated floors and fans capable of delivering airflow rates of at least 0.33 to 0.5 cfm/bu.

Airflow rates of 0.1 to 0.2 cfm/bu normally used for aerating dry corn (corn with less than 16 percent moisture content) are not adequate to safely hold corn with less than one month of shelf life.

Additional details of aeration system design and management can be found in NebGuides *G84-692, Aeration of Stored Grain*; *G94-1199, Management to Maintain Stored Grain Quality* and the MWPS publication, MWPS-22, *Aeration System Design*.

Dry corn aeration systems can be used to hold lower moisture corn for extended periods of time.

Generally, longer term wet corn storage is possible only if corn temperatures are maintained below 50° F. In Nebraska, these temperature levels can typically be maintained from Oct. 15 through April 15.

Nebraska Conditions

For corn aerated continuously, it is obvious that corn temperatures will not remain constant, because outside temperatures change with the seasons. This makes it difficult to apply the information in *Table I*, especially where the corn is held for periods longer than one month. *Table II* shows the effect of harvest moisture content and harvest date on the length of time aerated wet corn can be safely stored under average Nebraska weather conditions.

Table II. Recommended airflow rates and dates to which corn can be held for Nebraska weather conditions.

		Harvest Date			
		Oct. 1	**Oct. 15**	**Nov. 1**	**Nov. 15**
Moisture Content, %	**Recommended Airflow Rate (cfm/bu)**	Date to which corn can be held			
16	0.1 - 0.2	June 1	June 1	June 1	June 1
18	0.1 - 0.2	May 1	May 1	May 1	May 1
20	0.2 - 0.5	Jan. 1	March 1	April 1	April 1
22	0.33 - 0.5	xxxx	Jan. 1	March 1	April 1
24	0.33 - 0.5	xxxx	xxxx	Feb. 1	March 1
26	0.33 - 0.5	xxxx	xxxx	xxxx	xxxx
xxxx Corn can only be held for periods of one month or less. See *Table I* for recommended storage periods.					

If moisture contents are below 18 percent, corn can generally be stored until June. With higher moisture contents, safe storage periods vary depending upon when the corn is harvested. Corn harvested late in the year is cooler and can generally be held longer into the spring.

Notice that regardless of how late in the year the corn is harvested, **it still is not possible to hold corn over 15 percent moisture content into the summer months**. This reflects the fact that it is impossible to run aeration fans under summer conditions and still keep corn temperatures cool enough to retard mold growth.

The recommended wet corn holding periods shown in *Table II* were determined using average Nebraska weather data in a storage simulation model assuming continuous aeration fan operation. While continuous fan operation is preferred, it is not always required to maintain cool corn temperatures and control mold activity. Once corn is cooled below 35°F, respiration of corn and molds is slowed and the fan needs to be operated only enough to ensure that temperatures remain at that level.

Because mold development is much faster with higher moisture corn, continuous fan operation is recommended if moisture contents exceed 22 percent. For corn moisture content levels less than 22 percent, run the fan continuously until mid- or late-December, and then run the fan one night per week over the winter to keep the corn cool. Check the corn weekly for signs of heating. Turn the fan back on and run it continuously after March 1. Be prepared to move the corn out of storage as average

temperatures approach 50°F.

Do not expect to dry corn in a system designed to temporarily hold wet corn, or even in a normal aeration system. Continuous aeration will dry corn very little during the fall and winter. With 0.1 or 0.2 cfm/bu, there is not enough airflow to change the moisture content more than 1 percentage point.

With these low airflow rates, drying times are so extended that some of the corn usually goes out of condition before drying is complete. The best chances for success are with systems designed for airflow rates of at least 0.5 cfm/bu and filled with corn no wetter than 18 percent moisture content. For this situation, drying can be successfully completed if the fan is run continuously until the corn is dried.

Worksheet to calculate remaining storage life

Operation	Length of Time in Operation (Days)	Total Time (Days)	Grain Temperature (0F)	Moisture Content (% wb)	Shelf Life From Table I (Days)	Storage Life Used (%)	Storage Life Remaining (%)
—	—	0	—	—	—	—	100

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